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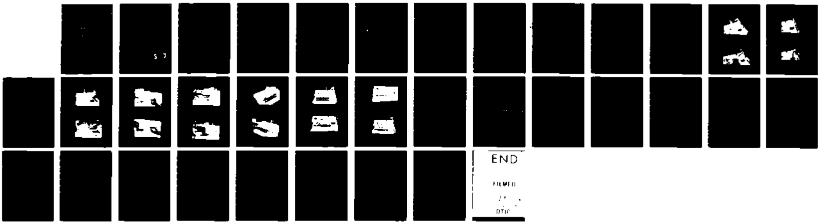

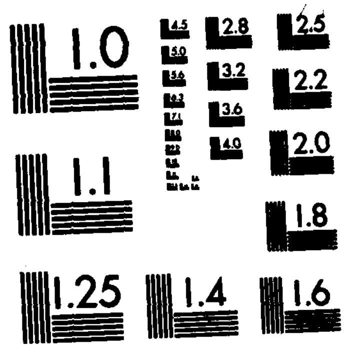

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CECOM -81-C-0085-2

FIELD EXPEDIENT REPAIR OF FIBER OPTIC CABLES

JOHN G. WOODS
TRW INC.
Electronic Components Group
Research and Development Laboratories
Philadelphia, PA. 19108

November 1982

INTERIM REPORT FOR PERIOD
1 MAY 1981 - 31 OCTOBER 1982

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This second interim report describes the development of a field expedient fiber optics cable splicing system. The field splice kit will include a manually operated splicing machine which includes all of the tools, mounted on a single platform, for making the field repair. The splice consists of glass four-rod alignment guides pre-mounted in the splice housing, which also provides the means for fiber and cable retentions. The Phase I brassboard splicer is described in detail with the aid of photographs. The Phase II design is based on the concepts used in the brassboard model, with many

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modifications to improve the ease and speed of repair, as well as to reduce weight and cost of the repair kit.

PREFACE

This is the second Semi-Annual Report for the work being performed on contract number DAAK80-82-C-0085, "Field Expedient Repair of Fiber Optic Cables". The funding for the development of the repair system is provided by the U.S. Army Communications - Electronics Command (CECOM). Technical direction and coordination is provided by Claire E. Loscoe, the cognizant engineer at CECOM.

The development work performed to date represents the efforts of: Dr. Malcolm H. Hodge, Manager, Fiber Optic Development; Joseph F. Larkin, Senior Mechanical Engineer; Henry D'Amico, Design Engineer; Jeffrey Ogilvie,Jr. Designer; and John G. Woods, Program Manager. All are members of the TRW Electronic Components Group, Research and Development Labs. in Philadelphia.

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1.0 INTRODUCTION

This program is directed toward developing hardware and procedures for field repair of tactical fiber optic communications cable.

When twin metallic coaxial cable is damaged, connectorized sections are replaced in the field. Fiber optic cable will be deployed in lengths of one kilometer or more, making it attractive to consider rapid, temporary field repairs for rapid restoration of service.

This report is the second semi-annual progress and status review of an exploratory development program to obtain a field expedient repair technique, and tool kit, for fiber optic cable. The concept being developed involves the use of four-rod glass alignment guides to provide precise fiber alignment. The guides described in an earlier report (1), are enclosed in a splice housing to give the repair the mechanical strength and protection to maintain the communication link. The tools for stripping and preparing the fiber ends will be built into one assembly for ease of operation in the field.

Throughout the report, the complete cable repair is referred to as a "repair" or as a "cable splice", and includes the alignment guides, cable retention means and splice housing, or enclosure. A tool assembly, designated as a "splicer", is used to strip the cable jackets, crimp cable and fiber retention sleeves and prepare the fibers for connection.

2.0 TECHNICAL DISCUSSION

The basic approach to the development of the field expedient repair system continues to be to have all the tools in one module, with all prepared cable and fiber lengths determined by pre-set tool and fixture positions. The field operator will not have to perform any precise manipulations of the fibers or tools in preparing the cable splice.

In the past six months, several major tasks have been performed, which are discussed under the following headings:

2.1 Phase I Brassboard Splicer Evaluation

2.2 Phase II Splicer Design

2.3 Prototype Splice Housing

2.3.1 First cable splice design

2.3.2 Second cable splice design

2.1 Phase I Brassboard Splicer Evaluation

The previous Interim Report described the concept and operation of the splicer. A full size wooden prototype of the splicer had been constructed to check and demonstrate the concepts to be used. In this reporting period a complete working brassboard of the splicer has been constructed, and preliminary design modifications and adjustments have been made.

Photographs of the experimental splicer are shown in Figures 1 through 16. In Figure 1 the cable is in position for stripping the outer cable jacket, with the cutting blades closed by the lever-operated cam in the upper right hand corner of the splicer platform. By pulling the cable to the right, the outer jacket is stripped off exposing the Kevlar strength member strands (Figure 2). The inner jacket is stripped, in a like manner, using a second set of stripping blades operated by the same lever as was used for the outer jacket. See Figures 3 and 4.

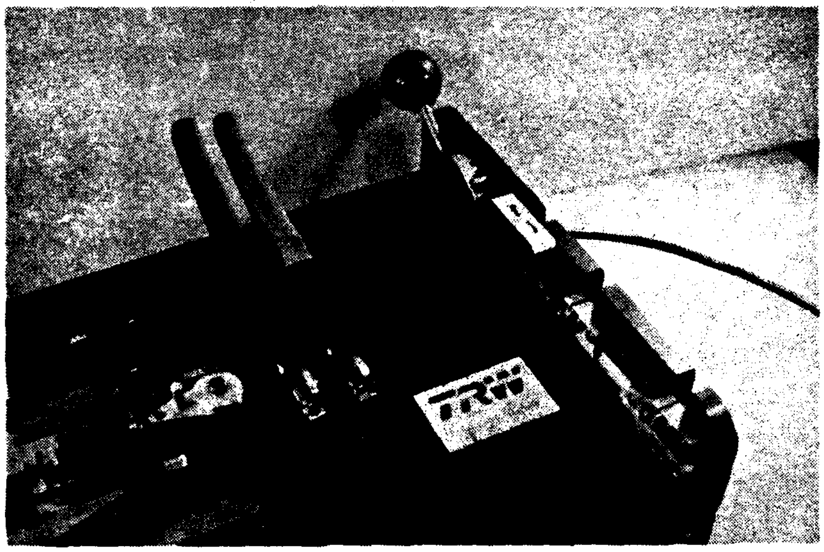


Figure 1. Stripping Outer Jacket

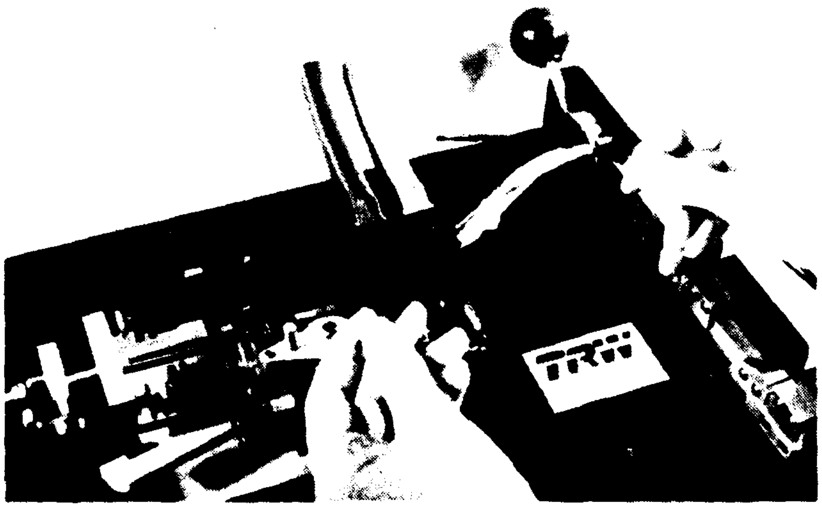


Figure 2. Outer Jacket Removed

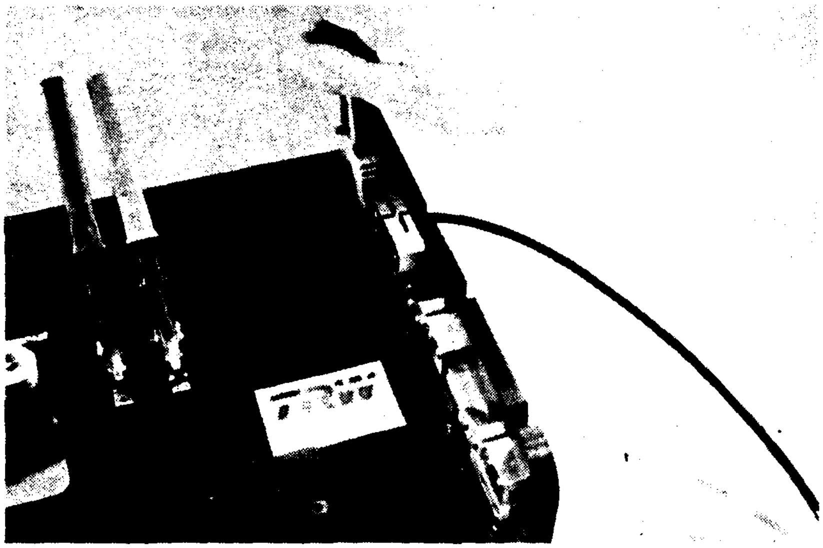


Figure 3. Stripping Inner Jacket

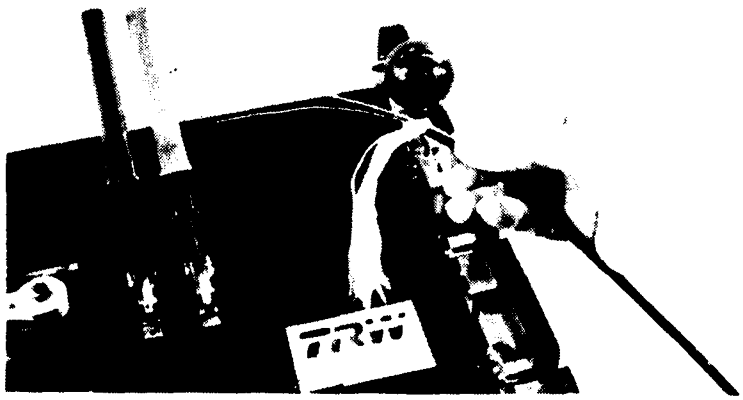


Figure 4. Inner Jacket Removed

Figures 5 and 6 show the operations involved in locating the strain/retain ring and crimping sleeve in place on the cable and crimping to retain the Kevlar strands. Locating sleeves are then crimped on the fiber jackets as shown in Figures 7 and 8.

The two fiber jackets are stripped to expose the fiber to a specific length, as shown in Figures 9 and 10. In this brassboard model, the fibers are scribed and cleaved individually with the scribing tool, which is on the same sliding carriage as is the fiber stripper. Figures 11 and 12 show the fiber being scribed, and after cleaving,respectively.

In the final assembly, the fibers and crimped sleeves are placed in the splice housing (Figure 13) while simultaneously feeding the two fibers into the glass alignment guides in the center of the housing. The splice housing is closed (Figure 14) and rotated 180° (Figure 15). The other cable end to be spliced is prepared in the same manner as was described in the preceding paragraphs. The splice housing is reopened, the second cable end inserted and the housing closed and latched, shown in Figure 16.

It is estimated that,based on brassboard function,the entire cable repair can be accomplished in less than 15 minutes under benign conditions.

Several minor modifications and adjustments have been made in the brassboard splicer to improve the stripping and crimping tools. The splicer now works well with the ITT #T-2001-06 cable. The brassboard tool will continue to be used for preparation of interim repair and test samples, as well as for a tryout vehicle to test tooling modifications for the future Field Expedient model.

2.2 Phase II Splicer Design

An improved splicer design is underway, using the principles of the brassboard model, with modifications to make the operations easier to perform and to decrease total weight (now calculated to be less than 10 lbs., compared to 19 lbs.

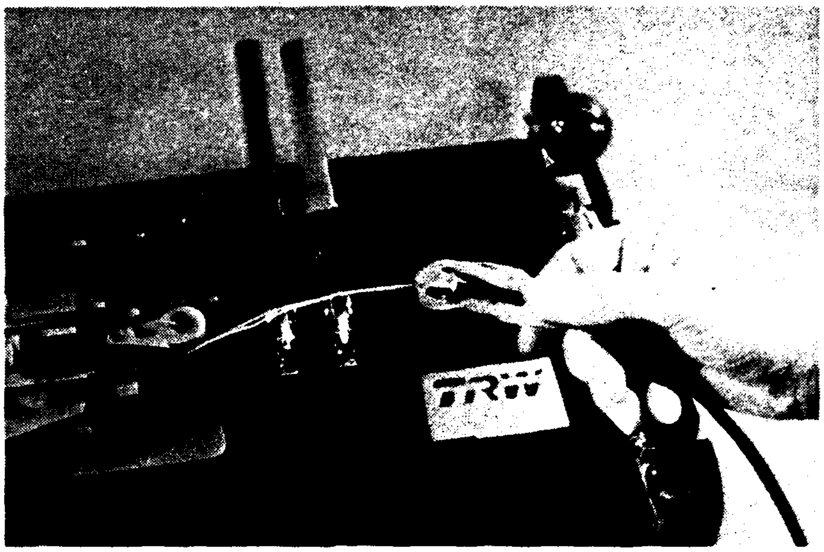


Figure 5. Strain/Retain Ring on Cable

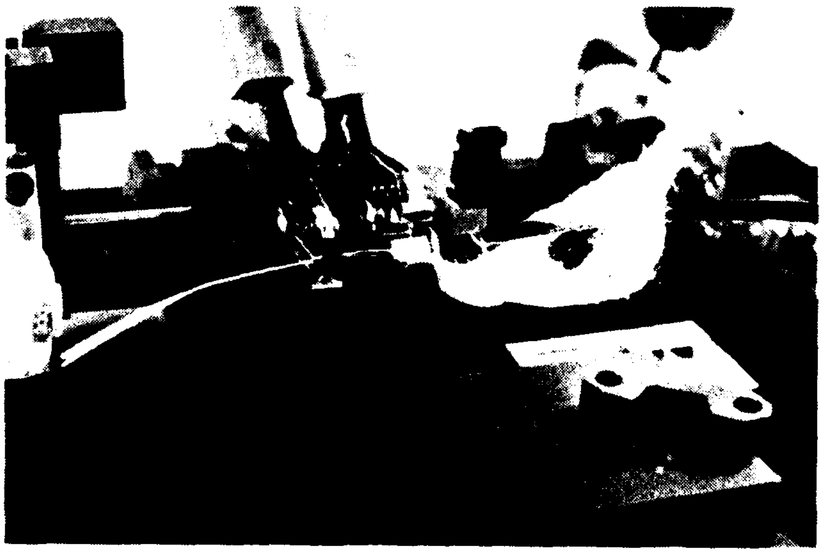


Figure 6. Crimping Sleeve over Kevlar

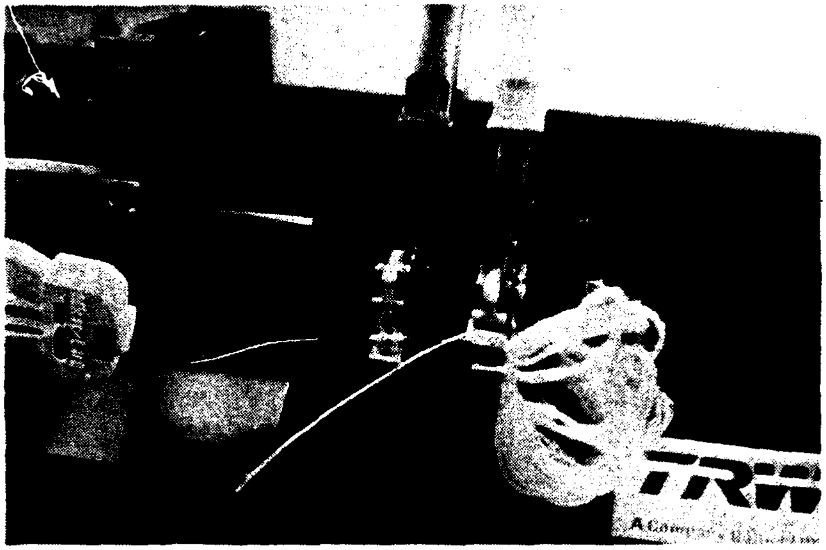


Figure 7. First Fiber Crimping

Figure 8. Second Fiber Crimping

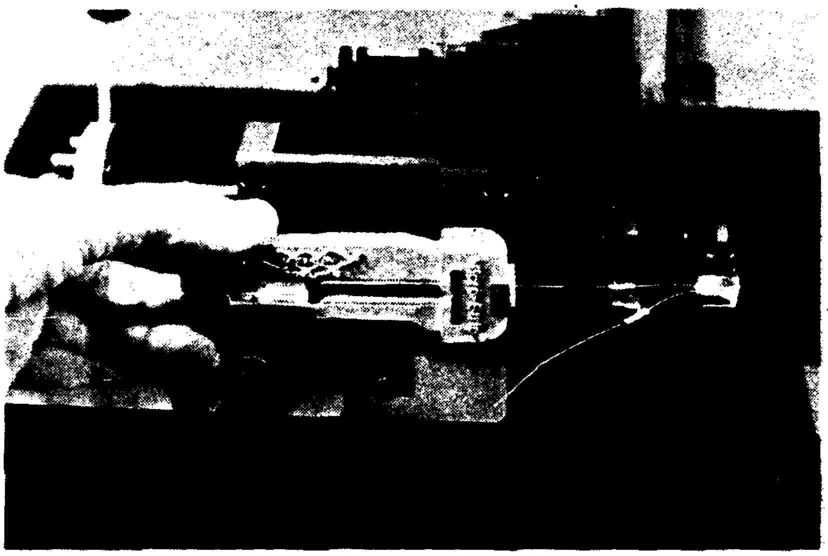


Figure 9. Stripping Fiber Jacket

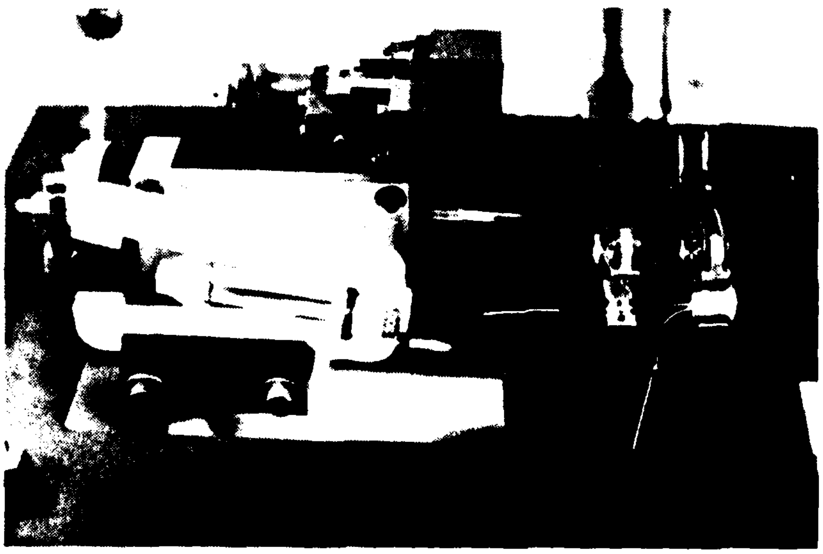


Figure 10. Fiber Jacket Stripped

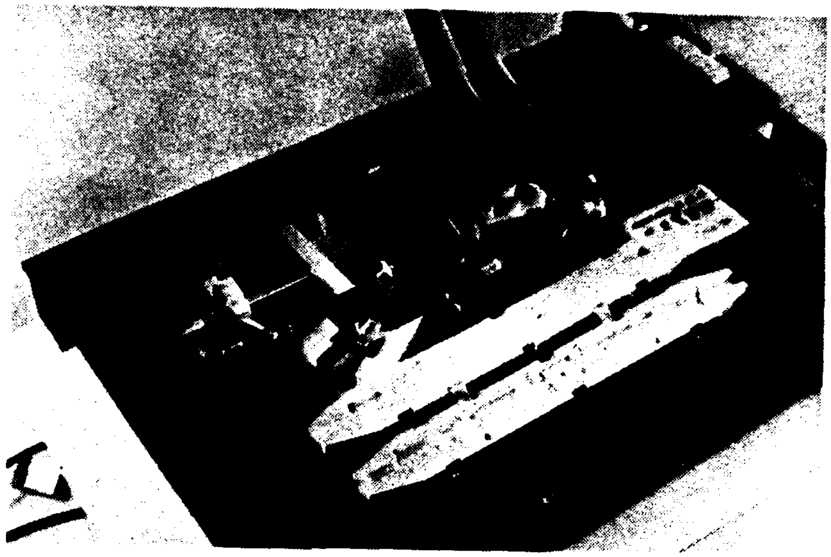


Figure 11. Scribing Fiber

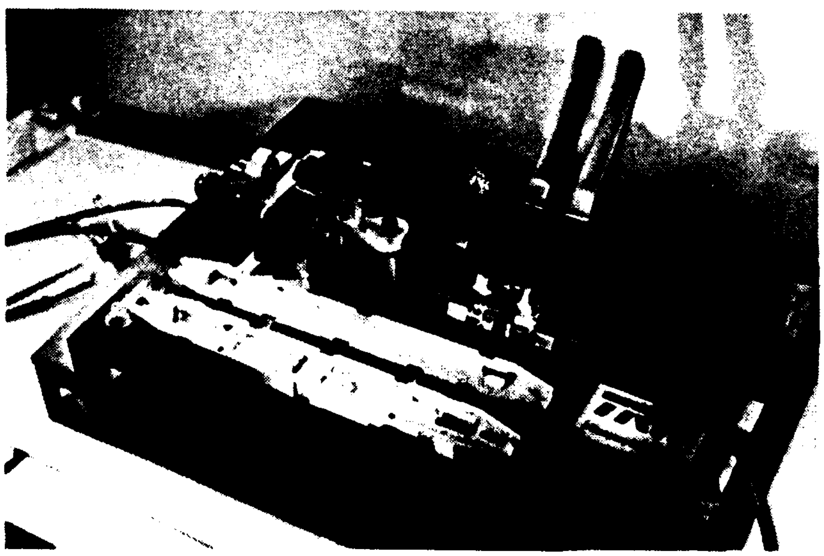


Figure 12. Fiber Cleaved

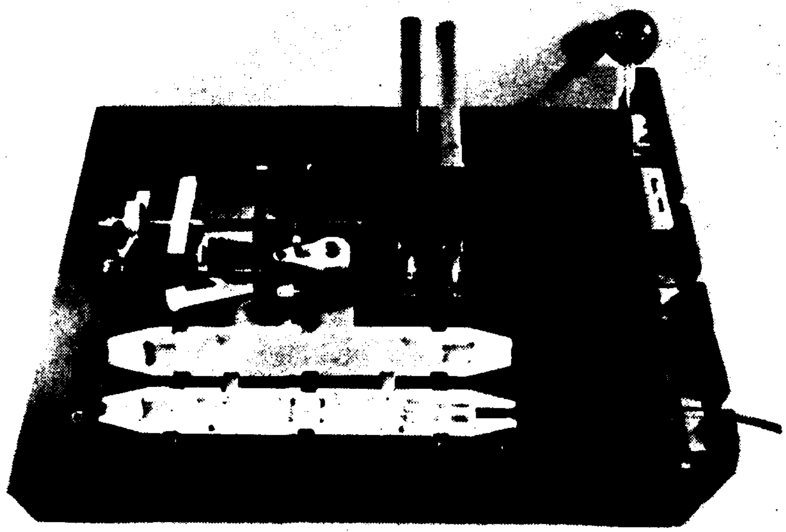


Figure 13. Prepared Cable in Splice Housing

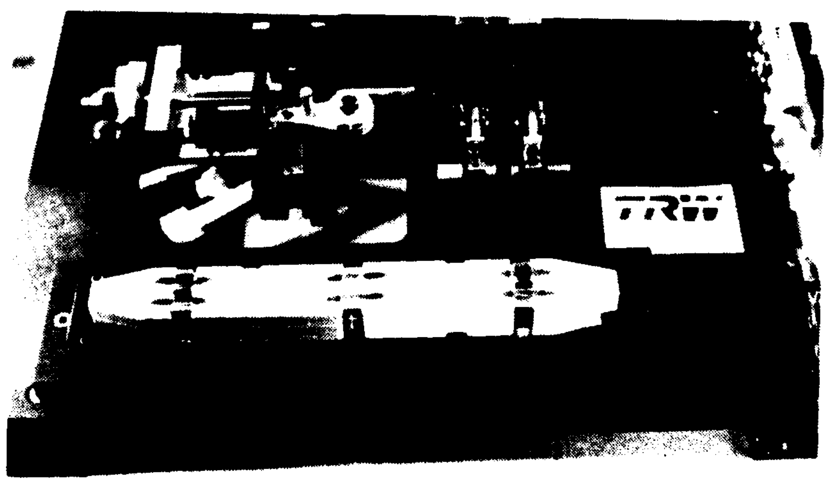


Figure 14. Splice Housing Closed

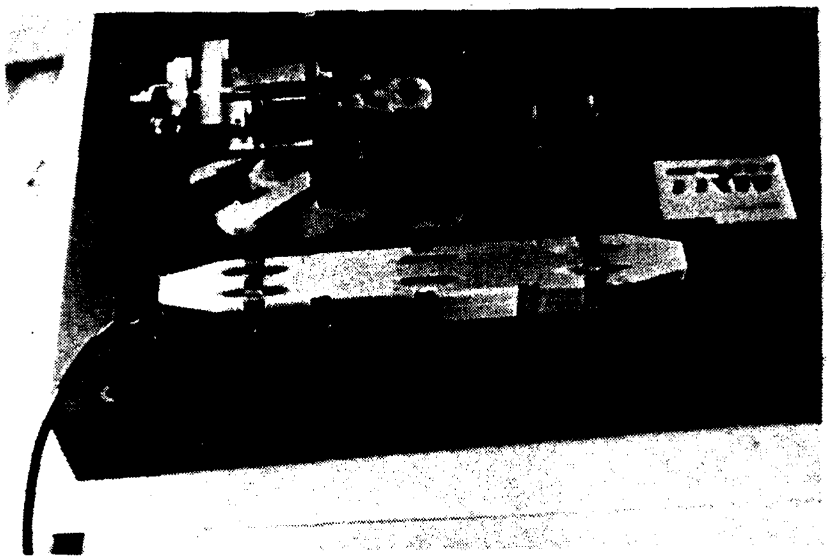


Figure 15. Splice Housing Rotated

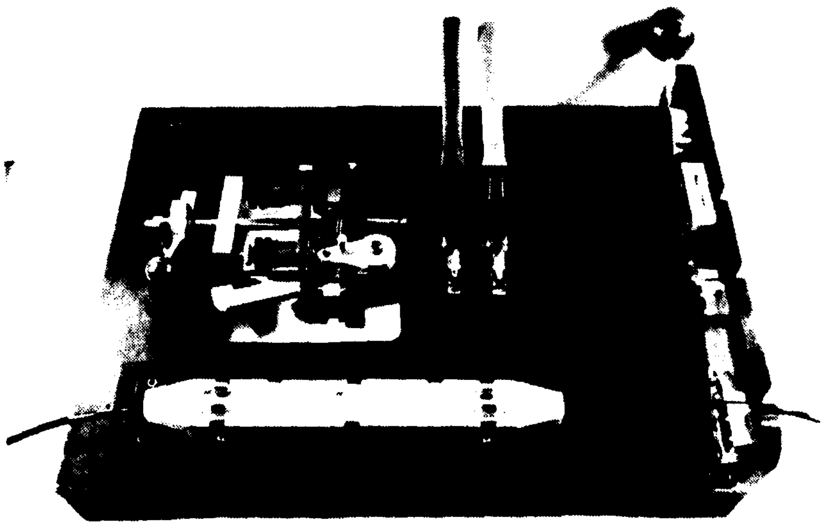


Figure 16. Completed Splice on Fixture

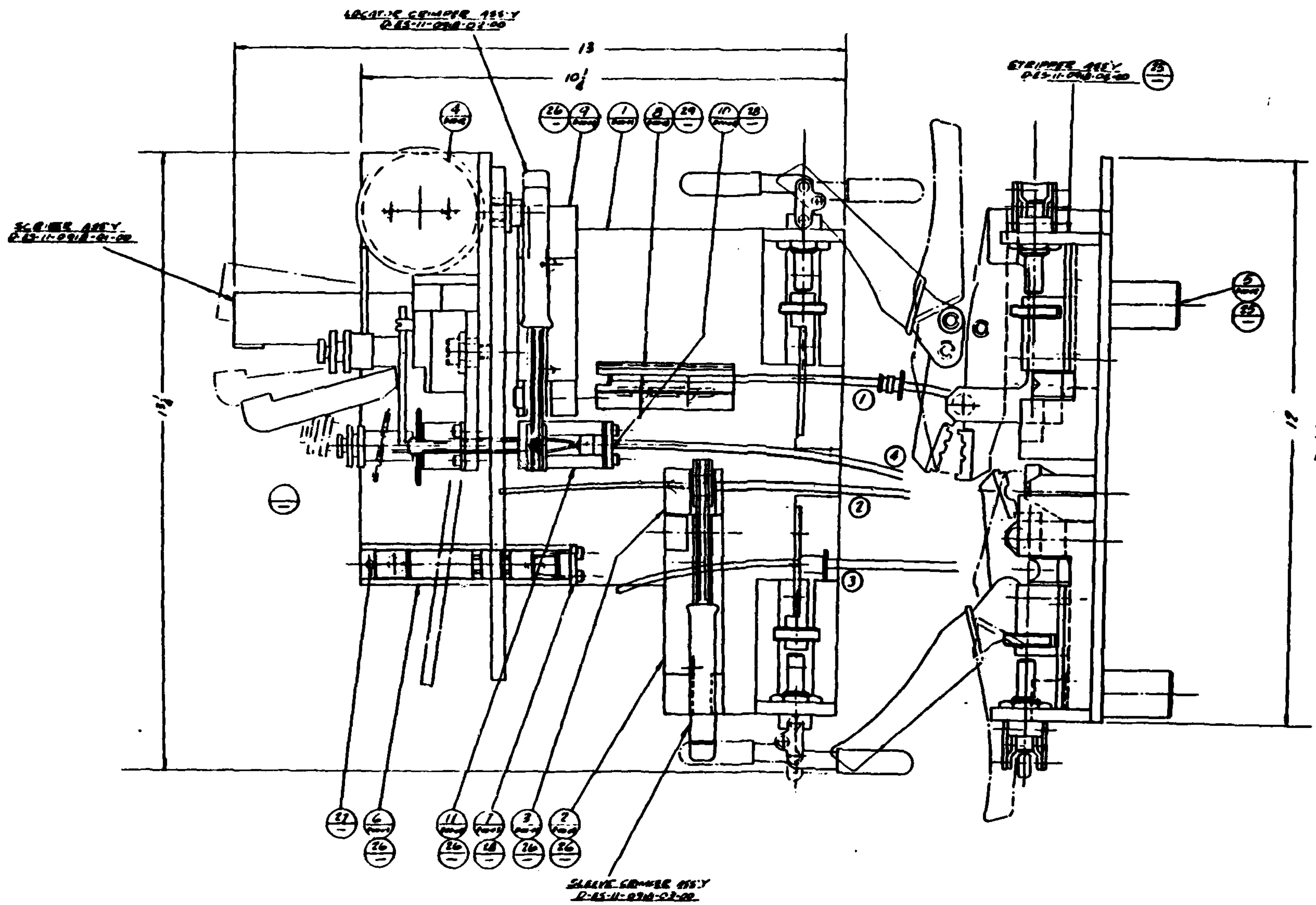
for the Phase I Splicer).

Figure 17 shows the preliminary layout of the splicer. Some of the stations have been moved from their original positions on the brassboard, to make the operations easier to perform. Toggle clamps have been substituted for the lever operated cam to close the cable jacket stripping blades. This was done to provide positive actuation of the blades during both opening and closing. In the brassboard model, a spring return was used to open the blades which may not be reliable when dust or dirt gets into the mechanism.

The crimping tools have been separated to make it easier to operate them individually and to facilitate crimping the Kevlar sleeve before stripping off the inner jacket. This order of operations makes it easier to assemble the sleeve to the cable, without having to thread the separated fibers through the sleeve.

Extensive modifications were made to the design to reduce weight and cost, including the use of off-the-shelf toggle clamps, a cable length gauge made of aluminum sheet and a thinner, smaller base plate.

The four positions of the cable for processing, prior to assembly into the splice housing sled, are shown in Figure 17. Position (1) is the station where the outer cable jacket is stripped, the strain/retain ring being slipped on before placing the cable in the toggle operated stripping blades. Stripping is accomplished by pulling the cable to the right. At position (2), the cable crimping sleeve is slipped over the cable and Kevlar strands, and then crimped in the mounted crimping tool. The cable is moved to position (3), where the inner cable jacket is stripped with the second set of stripping blades. The remaining fiber preparation operations are performed in position (4): The two locating sleeves are crimped in a single action over the fiber jackets; the fiber jackets are simultaneously stripped from the two working fibers by two stripping tools mounted in tandem. The operation is accomplished by actuating a toggle which depresses



PHASE II SPLICER

fig. 17

the handles of the strippers, and then by moving the lever to the left, rotating the tools about the bearing axis in the upper left hand corner of the platform. After fiber jacket removal, the scriber is moved into working position, as shown on the drawing. The two fibers are then scribed and cleaved in single motion. This completes the preparation of the cable and fibers for one cable end.

The prepared cable is lifted from position (4) and placed in the sled at the lower left side of the platform. The crimped sleeves and the slots in the sled locate the fibers in the correct position to permit automatic insertion of the fibers in the fiber alignment guides. (See the cable splice design discussion below). As before, the same procedure is used to prepare the other cable end and the splice is completed.

Among the major improvements of the splicer design just described compared with the brassboard tool, are those involving the positioning and preparation of the fibers. Insertion of the fibers into the stripping tools will be facilitated by conical "lead-ins", or funnels, to lead the fibers into the strippers. Several operations are performed on both fibers simultaneously: crimping of the fiber sleeves; stripping of the fibers; scribing and cleaving the fibers. The fine manipulation and skill required for handling of fibers has been virtually eliminated by the tool improvements and splice housing revisions. As was the procedure in the design of the Phase I splicer, a full scale wooden model has been constructed, and is being used for three-dimensional visualization of tool placement and optimization.

2.3 Prototype Splice Housing

During the past period, the first splice housing was built and evaluated. The basic principles are sound, but it became apparent that the use of a separate insert, or sled, would substantially aid in the assembly of the fibers into the alignment guides. The second cable splice design incorporates this approach.

2.3.1 First Cable Splice Design

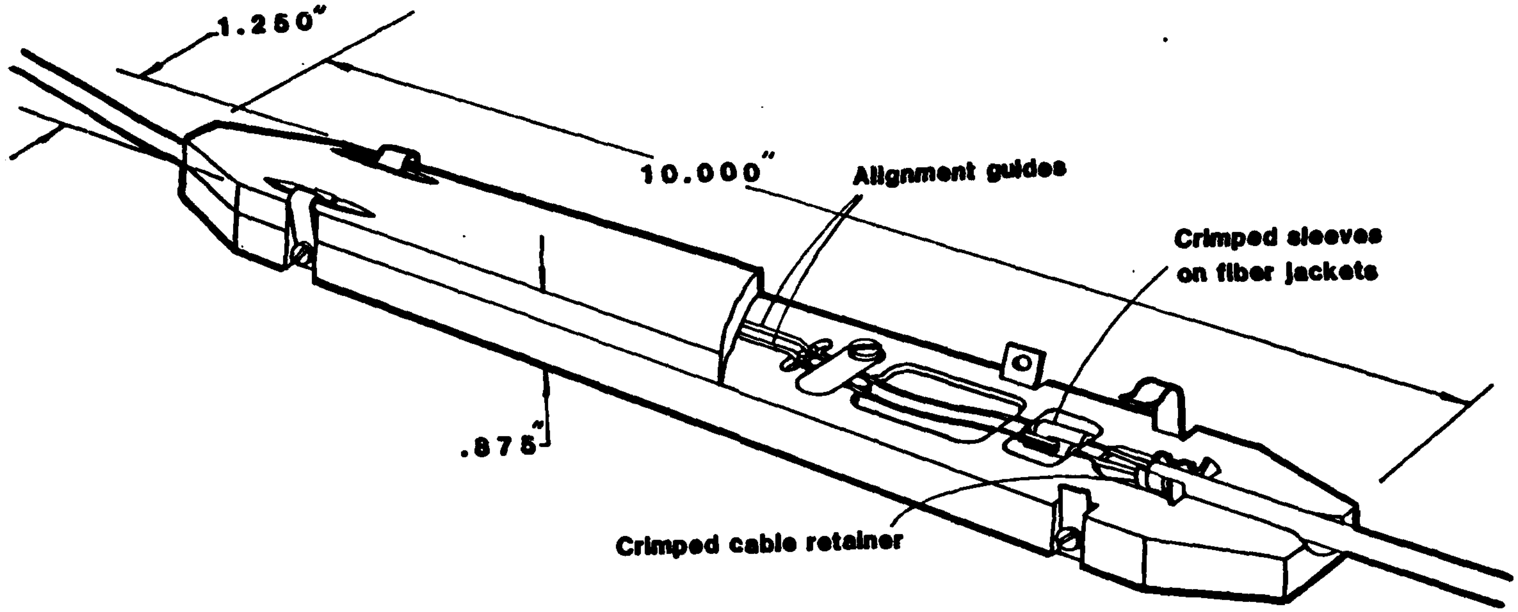
A model of the initial cable splice housing has been constructed and was used in the evaluation of the Phase I brassboard splicer. This is the housing that is shown on the splicer platform in Figures 11 through 16. Figure 18 is a line drawing, showing the completed cable splice in more detail than can be seen in the photograpsh. The drawing shows the crimped cable retainer, which captures the Kevlar strength members. The crimped aluminum sleeves (with rubber liners) on the fiber jackets serve to prevent any motion of the fibers in the alignment guides, as well as to provide the precision location of the fibers necessary to insure mutual contact of strain-relieved fibers in the four-rod alignment guides. The rubber liners, which protrude from the proximal end of the aluminum sleeves cause the sleeve to locate at the rear end of the housing cavity. The principle of the guides was described in the first Interim Report [1].

Assembly of the prepared cable in the housing is simple: the two cleaved fibers are fed into the chamfered slots; the crimped sleeves are placed in a housing cavity; and the crimped cable retainer is placed in its cavity. After assembly of both cable ends in this manner, the housing is simply closed and latched.

2.3.2 Second Cable Splice Design

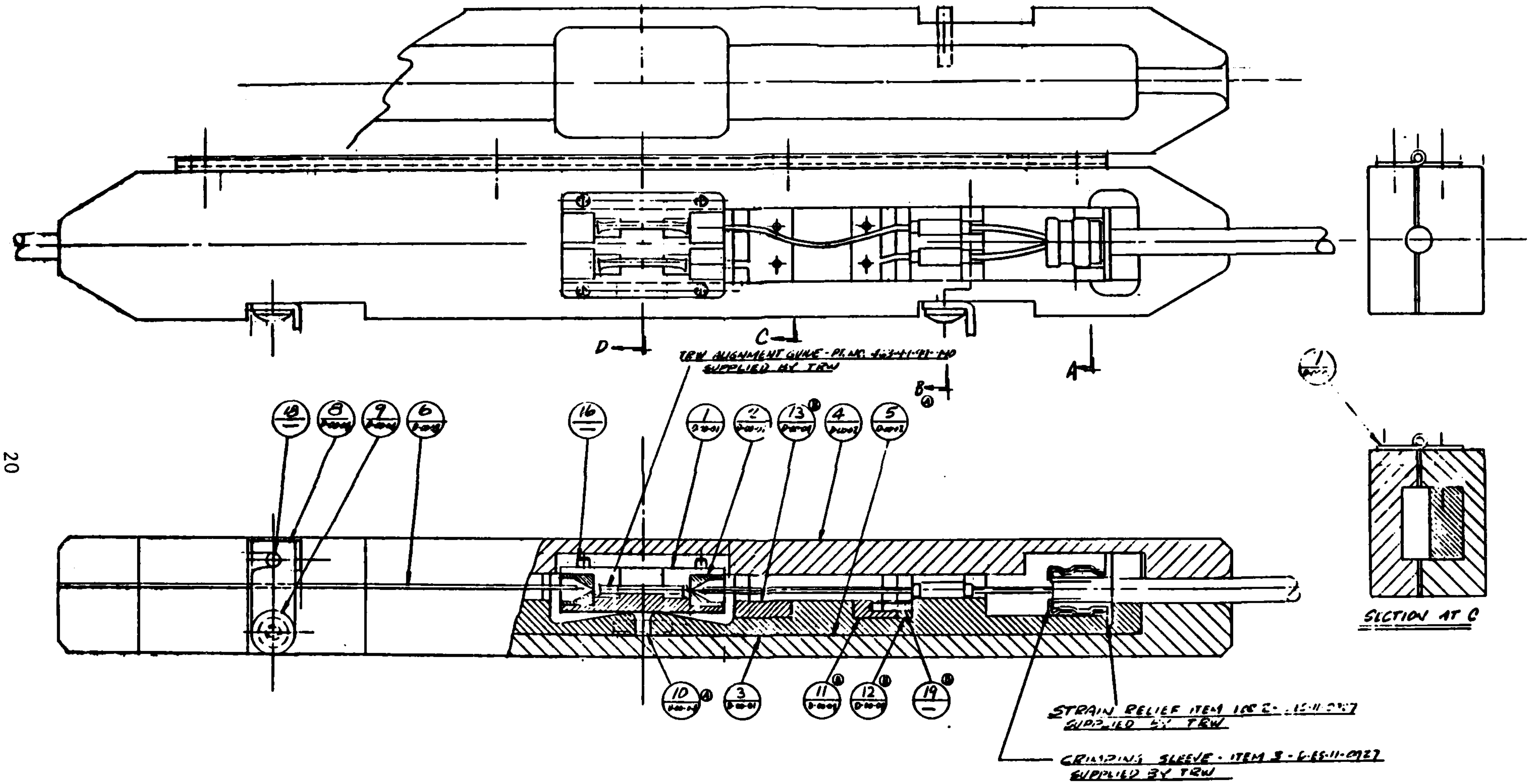
The concept of the first splice housing was found to be basically adequate for the field splice. However, it was realized that feeding the fibers into the slots leading to the alignment guides would be difficult under field conditions. Accordingly, the design was revised to make it possible to assemble the two prepared fibers, of one cable end, into the guides simultaneously.

An assembly drawing of the new housing is shown in Figure 19. After preparing a cable end as described in Section 2.2, the fibers, crimped fiber sleeves



FIRST CABLE SPLICE

fig. 18



SECOND CABLE SPLICE

fig. 19

and cable retainer are pressed down into prepared slots in one of the sleds which is temporarily mounted on the Phase II splicer. The sled is then nosed into the large housing cavity with the fiber ends toward the alignment guides. The dimensions and tolerances are such that the fibers must enter the plastic funnel-like openings which direct the fiber ends into the guides.

Other improvements to the clam shell splice housing design include a piano hinge, and simplified latches. A closed pore urethane gasket helps to prevent dirt and water from entering the assembled cable splice. As before, the alignment guides are pre-filled, with silicone fluid which precludes the entrance of dust and moisture in the area of the fiber ends and provides low loss index-matched optical coupling.

2.4 Project Status and Future Work

The Phase I brassboard splicer has been constructed and will be maintained for assembly of the interim and test repair samples.

The Phase II splicer is in the wooden prototype phase, and is being used for evaluating areas of tool interference, work flow, etc. The resulting design will be the basis for the deliverable splice kits at the end of the program.

A second model of the splice housing has been fabricated with the insertion sled feature. A sample repair will be made for evaluation and then the housings for the interim repair samples will be ordered in November. The results of processing and testing the interim repairs will be used in designing the production model of the splice housing, which is expected to include die cast, molded and stamped parts.

3.0 CONCLUSIONS

The development of the field splice system is proceeding close to schedule. The brassboard splicer will be used to prepare the interim repairs in the next reporting period. The new splice housing design will be used for these interim samples.

The operation of the splice repair equipment is being simplified, and the splicer is being reduced in weight at every step in the development. Both the splicer and splice housings are being designed for future manufacturing producibility and low cost.

There are no perceived unresolvable problems apparent at the present stage of development.

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